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Device for heat exchange
between flowable media

The invention relates to a device for heat exchange between flowable media at least one of which is in the liquid state.

Known devices (DE-A-196 51 988) which perform the function of affecting the thermal state of a fluid moving through them are widely used in technology, especially in the form of liquid/air coolers. When such devices are used in conjunction with hydraulic assemblies or production facilities, cooling air being used to chill operating fluids such as hydraulic oil, lubricants, or cooling lubricants, precautions must be taken to prevent stoppages or failure of a device as a result of temperature dependence of the viscosity of the fluid to be cooled. In order to optimize the efficiency of the heat exchange there are mounted in the paths of the fluid over which the fluid flows to be chilled inside the device blades or plates which customarily generate turbulence and around which the fluid must flow and is swirled in the process so that all components of the fluid flow come in contact with the walls surrounding the fluid path.

The structural members causing the swirling effect a certain amount of throttling of the fluid flow, so that a differential pressure determined by the throttling is established between the inlet chamber on the inlet side for the fluid to be chilled and the outlet chamber of the fluid. In the case of fluids to be chilled whose viscosity depends heavily on temperature, during operating stages in which the respective fluid is at a low temperature, as for example during startup stages in which the operating fluid in question is still cold, the correspondingly high viscosity of the

fluid may lead to excessive rise in pressure as a result of throttling in the fluid paths of the device. In order to prevent occurrence of such overpressure, which could result in malfunctions or damage, a bypass flow mechanism is customarily provided between inlet chamber and outlet chamber of the device; this mechanism is normally closed but has a pressure control mechanism which permits bypass flow of the fluid until the differential pressure drops to a certain value and the viscosity is accordingly reduced, when the fluid to be chilled has reached its operating temperature, a value at which the bypass flow is blocked and the fluid flows exclusively over the fluid paths for heat exchange.

DE-A-41 06 963 discloses a cooling device for fluid media, in particular water coolers for hydraulic assemblies operated by oil and internal combustion engines in which a cooling medium II to be chilled is brought into indirect contact with a cooling medium I so that heat exchange is effected, this device having a conventional oil-air cooler with connecting branches for intake or discharge of medium II into or from a cooling element having several parallel cooling channels spaced a certain distance from each other and the interstices between which are filled with blades, channels through which medium I moves in turbulent flow, and a cover being provided on the longitudinal sides having connecting branches, this cover being fastened in the area of the connecting branches and having interior and exterior seals, and having a hollow cast element in the shape approximately of a cuboid with several chambers and connections for intake and discharge of the medium I into which the oil-air cooler is introduced and in which it is secured so that when in the operating state the outer edge of the cover adjoins the edge of the housing by way of a seal to effect sealing.

This configuration results in a cooling device for fluid media which is cost-effective in production and is characterized by improved heat exchange. However, overpressures and accordingly damage to the known cooling device may occur especially in the startup stages in question, in which the respective fluid is at a lower temperature and may be highly viscous.

On the basis of this state of the art the object of the invention is to retain the advantages presented by the state of the art and further to improve the known devices so that they are characterized by especially simple structure which may be designed by a simple and cost-effective method and so that nevertheless a high degree of safety is reached with the medium to be chilled in operation over the widest possible range of temperatures.

It is claimed for the invention that this object is attained with a device having the characteristics specified in claim 1 in its entirety.

The device claimed for the invention has a heat exchanger block in which the fluid paths for the fluid participating in heat exchange extend between an inlet chamber delimiting the block on one side and a outlet chamber delimiting the block on the opposite side, fluid paths and paths of flow for conducting the other medium capable of flow, such as cooling air, alternating, that is, being superimposed one on the other in the block. A cover plate is provided as the upper element closing the block. In that, as specified in the characterizing part of claim 1, the cover plate has at least one interior passage which bypasses the fluid paths and extends as bypass channel from the inlet chamber to the outlet chamber, this passage may be closed or opened by means of a pressure control mechanism as a function of the differential pressure between inlet chamber and outlet chamber. It is accordingly claimed for the invention that the bypass mechanism provided as safety mechanism to prevent building up of overpressure is integrated into the cover plate of the heat exchanger block. This results in significant simplification of the structure of the device, which may be produced by simple and inexpensive means as desired.

In production of the heat exchanger block, the structural members forming the fluid paths and paths of flow may be soldered together one above the other to form a block with the desired number of elements, at the same time the cover plate forming the secondary flow mechanism may be fastened on the upper side of the block by soldering.

Production of the device is found to be particularly simple if there is provided as cover plate a section of hollow cast element made by extrusion in the form of a flat tube which is closed by a sealing plate at both ends. The section of hollow cast element may be extruded so that a single flat tube is formed, that is, so that a single passageway is made in the cover plate as thus formed. It may, however, be advantageous for the section of hollow cast elements forming the flat tube to be extruded so that the flat tube has two interior passages. In any event, that is, regardless of whether a single passage or several passages is or are formed, the wall of the flat tube is provided with passage bores which permit fluid connection to inlet chamber and outlet chamber in the end areas of each passage.

By preference at least one pressure control mechanism is provided for each passage of the flat tube. These mechanisms may be mounted in one of the passage bores in the flat tube.

In one preferred embodiment a return valve in the form of a spring-loaded seat valve is provided as pressure control mechanism for each passage.

An especially simple configuration is obtained when the flat tube forming the cover plate at the ends of the passage or passages is closed by a sealing plate, which is soldered on during soldering of the heat exchanger block. If the sealing plates extend over the ends of several passage, the sealing plates preferably have formed in them a passageway which makes possible a fluid connection between the passages. This passageway may be made in the form of an elongated recess which extends over the ends of the passages present in the flat tube.

The invention will be described in greater detail below with the aid of an exemplary embodiment illustrated in the drawings, in which:

- FIG. 1 shows a greatly simplified diagram of an exemplary embodiment of the device claimed for the invention in the form of an air/fluid cooler;

- FIG. 2 a diagrammatic outline designed exclusively to clarify the fluid flow in the exemplary embodiment and illustrating the bypass mechanism of the exemplary embodiment comprising associated pressure control mechanisms;
- FIG. 3 a section of a two-pass flat tube of the bypass mechanism of the flat tube corresponding to section III/III in FIG. 1; and
- FIG. 4 a top view of the interior of a sealing plate for closing of the flat tube shown in FIG. 3 on the end side.

In FIG. 1, which presents a greatly simplified diagram of an exemplary embodiment of the device claimed for the invention in the form of an air/fluid cooler configured by unit construction, an inlet chamber for delivery of the fluid to be cooled and a outlet chamber for removal of the fluid are identified as 1 and 3 respectively. Between inlet chamber 1 and outlet chamber 3 the heat exchanger block has alternating plate-shaped superposed heat exchange elements, specifically, fluid guide elements 5 having internal fluid paths 7 along which the fluid to be cooled flows from the inlet chamber 1 to the outlet chamber 3, and lattice elements 8 which form paths of flow for the cooling air which flows through and sweeps over the cooling blades of the lattice elements 8. The fluid guide elements 5 and the lattice elements 8 are plate-like structural members square or rectangular in outline.

The heat exchanger block with lateral inlet chamber 1 and lateral outlet chamber 3 and the stack of fluid guide elements 5 and lattice elements 8 positioned between them, which structural members are all soldered together, is closed at the top by a cover plate 9, which also is soldered on. This cover plate 9 forms a bypass mechanism for fluid connection between inlet chamber 1 and outlet chamber 3 bypassing the fluid paths 7 in the fluid guide elements 5; see the double directional arrows in FIGS. 1 and 2, these arrows illustrating the influx of the fluid from

the inlet chamber 1 into the cover plate 9 and flow of the fluid from the cover plate 9 into the outlet chamber 3 by way of spring-loaded spherical return valves 11.

The return valves 11, normally closed by spring loading, make up a pressure control mechanism which permits through flow of fluid when the differential pressure between inlet chamber 1 and outlet chamber 3 exceeds a threshold value preselected by adjustment of the force of the valve spring. Only one return valve 11 is shown in FIG. 1. However, with the aim of obtaining a valve passage cross-section of the size desired, several return valves 11 in succession are provided in the present exemplary embodiment. As is to be seen, FIG. 2, which, unlike FIG. 1, presents a vertical view, indicates the flow of fluid formed by the bypass mechanism through the return valves 11, that is, into the outlet chamber 3.

As shown in FIG. 3, the cover plate 9 is formed by a section of an extruded hollow cast element in the form of a flat tube which in the present example is a two-pass tube, that is, one which has two interior passages 13. Each of the two ends of the flat tube forming the cover plate 9 is closed by a sealing plate 15, which is shown in greater detail in FIG. 4. Through bores in the wall of the flat tube forming the cover plate 9 form the fluid connection between inlet chamber 1 and the interior passages 13 and the fluid connection of the passages 13 to the outlet chamber 3. The through bores associated with the inlet chamber 1, only one of which is shown in FIG. 1, are designated as 17. In keeping with the number of two passages 13 provided in the exemplary embodiment, two through bores 17 are provided at the inlet chamber 1 and two through bores 19 at the outlet chamber 3.

As shown in FIG. 2, a return valve 11 is mounted in each through bore 19, in order, as has been indicated in the foregoing, to obtain a sufficiently large valve passage cross-section without the need for using excessively large valves. In order to make possible, on the ends of the flat tube forming the cover plate 9, a fluid connection between the two passages 13, the sealing plates 15 are provided with a recessed oblong groove 21. In the case of the sealing plates 15

soldered to the cover plate 9 and the ends of the passages 13 the groove 21 extends over the ends of the two passages 13, as is shown by comparison of FIGS. 3 and 4, as a result of which a passageway is formed which effects fluid connection between the passages 13 at the two ends of these passages.

In order to permit access to the return valves 11 performing the function of pressure control mechanism when the device has been completed, access bores 23 are made in the wall of the flat tube forming the wall of the cover plate 9, which bores 23 are made opposite the respective return valve 11; see FIGS. 1 and 3. As shown in FIG. 1, the access bores 23 may be closed off by a sealing component 25 which may be in the form of a screwed-in cover component or the like.

In one embodiment of the invention not shown, the respective pressure control mechanism 11 may also consist of a closing component actuated by means of pressure and/or temperature, such as one in the form of a temperature-dependent elastic element. If the medium to be chilled is cold, a correspondingly high pressure is built up in the device and the pressure control mechanism 11 performs the bypass function of freeing the cooler. If the temperature of the medium to be cooled then rises and the medium is accordingly fluid, the medium may then flow directly through the cooler and bypass the bypass function, the closing component closing the bypass at a higher temperature. A closing element such as this may, for example, be appropriately produced from an elastic element.

The bypass device claimed for the invention may also be subsequently connected to existing coolers, since by preference the bypass device is of a height which corresponds to the structural height of a fluid channel 7 and a following blade channel 8. Consequently, if the respective upper row of blades together with the fluid channel is removed from a cooling mechanism which has already been delivered, structural space is created for subsequent mounting of a bypass device of standardized height and welding it on, so that subsequent

outfitting with the bypass devices is immediately possible without significant reduction in the cooling efficiency of the cooling device as thus converted.